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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

May 8, 2004

Re: Invention: **Process to Fracture Connecting Rods
and the Like with Resonance-Fatigue**

Application No.: **10/643,910**

Filed on: **August 20, 2003, which is pending claims the
benefit of 09/599,409**

Inventor: **Guirgis, Sameh**

Art Unit: **3724**

Examiner: **Stephen Choi**

The Commissioner of Patents and Trademarks
WASHINGTON, D.C.
U.S.A. 20231

**Explanation of the Relevance of the Documents Listed in the
Information Disclosure Statement (IDS)**

Dear Sirs

Please find attached herewith a second Information Disclosure Statement (IDS) submitted by the Applicant of the patent application referred to above (herein and after is referred to as the **Applicant**). In the following, please find explanation of the relevance of the documents listed in the IDS, particularly; the information contained in a thesis entitled "Fatigue Crack Propagation in Steel Components at Resonance" authored by the Applicant and published by the University of Windsor, Windsor, Ontario Canada in the year 2000 (herein and after is referred to as **Thesis**) and the information contained in US application number 10/205,785; Filed on July 26, 2002 for an invention entitled "Dynamic Splitting of Connecting Rods"; Publication Number: US 2003/0019100 A1; Publication Date January 30, 2003, Inventor Name: Gottfried Hoffmann (herein and after is referred to as **Hoffmann**). Copies of the IDS, this letter, the attached materials and the complete thesis have been mailed to the Office.

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I **Developments of the Connecting Rods cracking Technology**

1. It is desirable in the industry to make connecting rods from relatively ductile materials; however, the attempts to crack relatively ductile materials since the early developments of connecting rod cracking technology in the early 70s (U.S. Patent Nos. 3,751,080; 3,818,577 and 3,994,054) were unsuccessful. For this reason connecting rod are generally made of specially developed materials –such as powder metals- so that they can be easily fractured.
2. **The Resonance-Fatigue technology** is the first technology that can be used successfully -from a commercial point of view- to crack more ductile and high strength materials. In fact, it **represents a breakthrough in the art**.
3. The impact of the Resonance-Fatigue cracking technology on the market is substantial. By having a process to crack connecting rods and other items which are made of high-strength ductile materials; it has become possible to reduce the weight of connecting rods - and other parts of the engine – without performing any additional manufacturing steps. Thus, significant savings can be achieved. Moreover, combustion engines built with such lighter connecting rods should have lower reciprocating mass, which increases fuel economy and engine efficiency. Furthermore, the very efficient cracking method can be used to crack large size connecting rods -a task that was not possible before- which should result in substantial reduction in their manufacturing costs. In addition, the method could be used for new applications in the industry.

II **Basic Scientific Concepts Utilized in the Resonance-Fatigue Technology**

1. The Resonance-Fatigue technology utilizes **four mechanisms** to crack connecting rods and similar items, namely; **fatigue, resonance, prestressing and impact**. It is the first technology that utilizes fatigue or fatigue-at-resonance in the cracking of connecting rods. Before Canadian Patent No. 2,287,140; there was no reference anywhere for utilizing fatigue or fatigue-at-resonance in the cracking process.
2. **Fatigue is the primary mechanism in the cracking process; the other three mechanisms are utilized to expedite the process and to make it very efficient.**
3. But why it was not expected before to utilize fatigue in the cracking process? Because fatigue crack propagation rates in steels are very slow. Figure 1 shows the fatigue

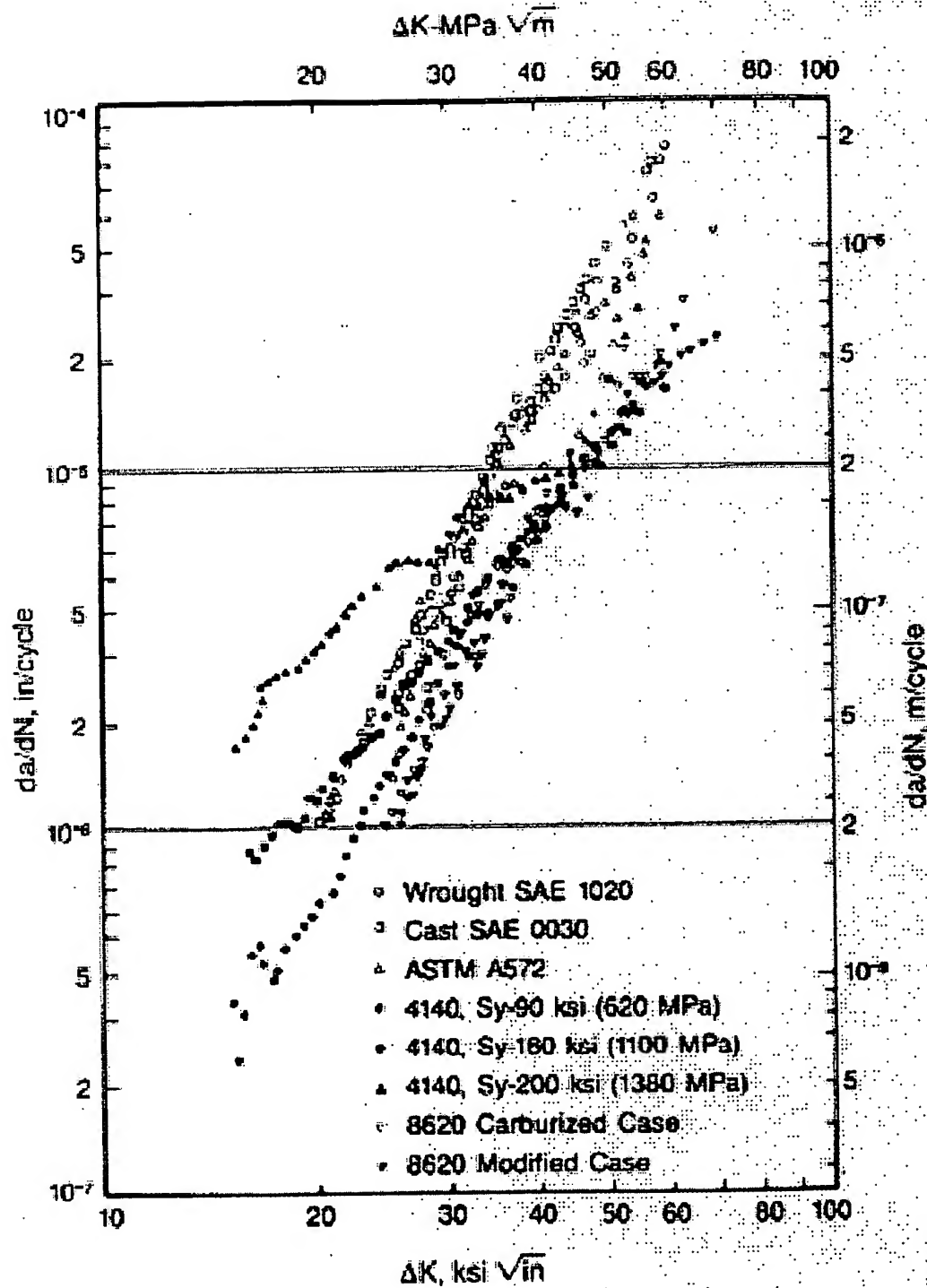


Figure 1
Fatigue Crack Growth Rates in Different Steels (SAE 1997)

crack growth rates in different steels¹. It should be noticed that fatigue crack propagation rate, especially in steels, is almost independent of the chemical composition and the other mechanical properties of the material (US 2003/0019100 A1 paragraph 36). It is shown that the fatigue crack propagation rate at a high stress intensity range (ΔK) of 30 MPa \sqrt{m} is as low as 0.00018 millimetre/cycle. In other words, a fatigue crack propagating at this rate will extend for a distance of about 0.018 millimetre in a hundred cycles (the same number of cycles reported in Hoffmann's tests). In an average size connecting rod of a light vehicle; a crack has to propagate for a distance of about 12 millimetres in order to complete the separation of the cap portion and the rod portion. Thus, it is apparent that using fatigue alone is not fast enough to meet the requirements of the industry, especially; considering the aim of the invention to crack tougher and more ductile materials which should require longer time to be cracked and knowing that the current time cycle for cracking a light vehicle connecting rod in the industry is less than 7 seconds. Practically, it is not possible to significantly expedite the fatigue crack propagation rate by applying a fatigue exerting force at a high frequency. The higher the frequency of the fatigue exerting force is; the lower the maximum stress intensity range that could be associated with the same force. Moreover, it should be noticed that if ΔK exceeds certain limits, then the cracking will not be brittle. Thus, for cracking items in a brittle mode by fatigue crack propagation alone; the process will remain relatively slow² regardless of the frequency or the stress intensity range of the fatigue exerting force.

4. However, the Resonance-Fatigue technology utilizes fatigue for a very important task: fatigue significantly weakens the connecting rod. While many methods have been utilized in the prior art to weaken the rod; fatigue has the advantage that it weakens the rod during the process only, not like any of the prior art methods such as reduction of the cross-sectional area, embrittlement, etc., which result in a permanent weakening of the rod that extends to its service life. It was concluded in the Thesis that a small extension of a fatigue crack substantially reduces the tensile force required to fracture a steel ring³.

¹ SAE (1997) "Fatigue Design Handbook" Society of Automotive Engineers, Fatigue Design and Evaluation Committee, Warrendale, PA.

² The exception of that is when fatigue is applied while a resonance condition is achieved.

³ "A small extension of the crack causes a significant increase in the stress intensity factor of the ring."; Thesis, pp 82.

5. The experimental part of the Thesis was conducted by prestressing and fatigue cracking steel rings (very similar to the crankbore of an average size light vehicle connecting rod) where the load was applied in a direction that is perpendicular to a predetermined fracture plane. **It was shown that propagating fatigue cracks for a distance of about 0.3mm reduced the load required to fracture the ring by about 50%¹.** It is worth mentioning that notches produced by machining have much less effect in weakening a steel ring (i.e. a crankbore of a connecting rod) than the effect produced by fatigue cracks².
6. Therefore, it is obvious from the information presented above that fatigue alone is not fast enough to crack connecting rods. Therefore, the Resonance-Fatigue technology utilizes three other mechanisms in order to expedite the process and to make it very efficient. The first additional mechanism is to apply fatigue exerting force at a resonant frequency so as to achieve a **resonance** condition in the connecting rod during the process. The advantage of achieving a resonance condition is that **at resonance the fatigue crack growth rate is extremely high comparing to the rate at other frequencies.** In other words, by applying fatigue at a resonant frequency, the crack propagates in a certain period of time for a much longer distance and, consequently; the connecting rod is much more weakened comparing to what would happen at non-resonant frequencies. This fact has been observed by many researchers and it was concluded in the Thesis³.
7. The second mechanism is the use of a **dynamic or impact force**. The use of fatigue exerting force results in the formation of fatigue cracks which continue to grow by maintaining the exertion of fatigue force. **It is obvious then that instead of waiting for the separation to be completed by fatigue alone; it is possible at a certain point – when the rod becomes weak enough- to apply a dynamic force to complete the separation by fracture.** This way the time of cracking a connecting rod is further shortened.
8. The third mechanism is to apply a **prestressing force (pre-load)**. By applying a prestressing force prior to the application of the fatigue exerting force, **the separation of the two portions of a connecting rod is accomplished by fracture once the fatigue crack propagates till its length reaches the critical length associated with the highest magnitude of the fluctuating fatigue exerting force.** In other words, since

¹ Thesis; pp 82 and pp 83; specimen number 6.

² Thesis; pp 24, 2.6.3 Cracks and Notches.

³ *"At resonance, the fatigue crack propagation rate is higher than the rate at other frequencies."* Thesis; pp 84.

applying a prestressing force raises both of the highest and lowest magnitudes of the fatigue exerting force (i.e. it shifts-up the fluctuation range), consequently; a shorter fatigue crack is needed to fracture the rod when a tensile prestressing force is applied, hence; a smaller number of load cycles and a shorter time is required to crack the rod¹.

9. From the above, it is **OBVIOUS** for a person who has ordinary skills in the art that there are many sub-combinations of the four mechanisms, namely; **Fatigue, Resonance, Prestressing and Impact**. Any of the following combinations and sub-combinations can be used to crack a connecting rod or a similar item to two portions: A) Fatigue B) Fatigue-Resonance C) Fatigue-Prestressing D) Fatigue-Impact E) Fatigue-Resonance-Impact F) Fatigue-Resonance-Prestressing G) Fatigue-Prestressing-Impact and H) Fatigue-Resonance-Prestressing-Impact. Moreover, any of the above-mentioned combinations and sub-combinations can be used in one of two arrangements, which were disclosed in the Resonance-Fatigue patent specifications, namely; the parallel arrangement (the preferred embodiment of the invention) and the perpendicular arrangement, which was referred to in US 6,644,529 col. 6; lines 22-27.

III The Real Scope of the Resonance-Fatigue Fracturing Process

1. The Resonance-Fatigue technology utilizes two new features in cracking connecting rods and similar items, namely; Fatigue and Resonance, which have never been utilized in the prior art for this purpose. It is for this reason that the title of the invention was chosen to be "Process to Fracture connecting rods and the Like with Resonance-Fatigue." However, the scope of application of the Resonance-Fatigue technology is **NOT** limited to the use of resonance and fatigue together as a combination as Hoffmann is attempting to portray. This fact can be easily concluded by reviewing base claim number 1 of Canadian patent number 2,287,140, which describes a process to fracture connecting rods using only fatigue exerting forces and impact; it does not include any reference to the use of resonance. Achieving a resonance condition was described in a multi-dependent claim number 5 as a limitation of the base claim and the subsequent three claims.
2. Moreover, all of the claims of US 6,644,529 do not include any reference to the use of resonance. Instead, a fracture process that utilizes a fatigue exerting force and an impactive force is claimed in base claim number 1. Moreover, independent claim

¹ For further information; see the explanation given in V.7.G for the cracking of specimen number 6.

number 4 describes a process to fracture a part having a bore therethrough using only a fatigue exerting force.

3. In the Resonance-Fatigue specifications it was stated that ***“(a) Fatigue: if the stresses in a pre-notched connecting rod fluctuate due to the application of harmonic forces (or any time varying forces), the pre-existing crack (stress-riser) will extend incrementally depending on the range of fluctuation in the stress intensity factor. It is important to notice that the crack growth relates to the change of the stress intensity factor, not to its absolute value. Moreover, as the crack grows, the absolute value of stress intensity factor will increase.”*** column 3, lines 2-10. It is obvious from the above that fatigue can be used alone to crack a connecting rod by maintaining the exertion of fatigue force; the pre-existing crack will extend incrementally until the complete separation is achieved.
4. Moreover, an express statement was made in the specifications indicating that it is possible to use fatigue exerting force and resonance alone to fracture connecting rods and similar items: ***“If the force components have the same sinusoidal time variation, with a frequency that is the same as or close to the natural frequency ω_r , a resonance condition occurs. Consequently, the fluctuation range of the stress intensity factor and its maximum value increase substantially. The crack extends, AND FRACTURE MAY OCCUR, depending on the relative magnitudes of stress intensity factor and material fracture toughness.”*** US 6,644,529 column 3; lines 31-38.
5. Furthermore, an express statement was made indicating that it is possible to eliminate any prestressing force from the process: ***“While the present description of the process incorporates all of the aforementioned factors, eliminating the prestressing forces or either of them should not be construed as a departure from the scope of this invention. This is a valid option, especially, for small size connecting rods. In this case, the procedure that was described earlier should be followed, with an exception that is to skip the steps related to the omitted force or forces.”*** US 6,644,529 column 6, lines 28-35.
6. It is worth mentioning that a fatigue exerting force is a force which fluctuate between a maximum and a minimum values, such force could be described as a harmonic force, cyclic force, periodic force, oscillating force, etc. Applicant referred to all of these variations as ***“(or any time varying forces)”*** US 6,644,529 column 3, lines 3-4. Therefore, the Resonance-Fatigue invention is not limited to the use of harmonic force as a fatigue exerting force.

7. While the preferred mode for carrying out the Resonance-Fatigue invention is described in the specifications as the use of two harmonic forces which are equal in magnitude and opposite in direction and acting along a straight line that is substantially parallel to the predetermined fracture plane so as to fracture a part having a bore therethrough (this arrangement can be referred to as a **parallel arrangement**). However, an express statement was made indicating that there are other modes to carry out the invention including the application of a harmonic force in a direction that is substantially perpendicular to the predetermined fracture plane: ***"Although the preferred mode for carrying out this invention has been set forth in this specification, it is obvious that there are several alternative modes. One of them for instance, is to apply a harmonic force to the cap, in a direction that is perpendicular to the predetermined fracture plane."*** US 6,644,529, column 6, lines 22-27 (this arrangement can be referred to as a **perpendicular arrangement**). The meaning of this statement is obvious to a person with ordinary skills in the art; it means that the process can be carried out by following the same steps as described in the specifications with an exception that the fatigue exerting force should be a harmonic force that is perpendicular to the predetermined fracture plane instead of being two harmonic forces which are equal in magnitude and opposite in direction and acting along a straight line that is substantially parallel to the predetermined fracture plane.
8. In criticizing the Resonance-Fatigue invention; Hoffmann mentioned that it requires computational modeling to determine the resonant frequencies (US 2003/0019100 paragraph 0014). In fact this is not true, firstly; the Resonance-Fatigue technology is not limited to the use of fatigue and resonance as a combination as was discussed earlier, secondly; the resonant natural frequency can be determined experimentally by conducting a simple test with trivial expenses; by subjecting the connecting rod to a harmonic force at different frequencies -using the same device to be used in implementing the cracking process- and recording the displacements which correspond to each frequency; the frequency that corresponds to the peak displacement is the resonant frequency which could be used in the process. This simple method was explained in numerous presentations by the Applicant before different interested parties. Thirdly, connecting rods are usually produced in very large quantities (millions); it is customary in the industry to create numerical models for connecting rods to conduct stress analyses to study their behavior during service life, the same numerical models can be used to conduct modal

analysis to determine the resonant frequency with trivial additional cost in a very short computational time.

9. Finally, Hoffmann is referring to additional loading stations and new part fixtures as additional needed items for using the Resonance-Fatigue technology!!! There is no need for additional loading stations or part fixtures to utilize the Resonance-Fatigue technology in cracking connecting rods. In fact, the same device depicted in Hoffmann's patent application can be utilized to crack connecting rods by the Resonance-Fatigue technology.

IV The Discrepancies in US Patent Application No. 10/205,785

Hoffmann describes tests to fracture connecting rods made of powder metals using a pre-stressing force and a fatigue exerting force. The tests were conducted by applying a pre-stressing force (a pre-load or a mean load) equal to about half of the critical load and then applying a fatigue exerting force (or oscillatory load amplitude) at a frequency of 10 Hz. The results of the tests are depicted in Figure 3 of the patent application. Here are some remarks regarding the tests:

1. What is the real number of load cycles that was required to separate the connecting rods? In Figure 3, the number of cycles is shown to be in excess of 1000 cycles for all connecting rod types, which mean that the process lasted for more than 100 seconds. However, in the text it was stated that the required number of load cycles is about 100 cycles which means that the process lasted for about 10 seconds.
2. What is the real fatigue crack extension in the tests? Assuming that the stress intensity range ΔK equals to $30 \text{ MPa}\sqrt{m}$ (a conservative high value) and using the equation for fatigue crack propagation in Ferritic-Pearlitic steels reported by Rolfe and Barsom¹ (which is suitable for powder metals):

$$\frac{da}{dN} = 6.9 \times 10^{-12} (\Delta K)^{3.00} = 6.9 \times 10^{-12} (30.0)^{3.00} = 1.8 \text{ E} - 07 \text{ meter / cycle}$$

then in a hundred cycles, the fatigue crack extends for a distance of 0.018 millimetre in the connecting rod and in a thousand cycles the crack extends for 0.18 mm!!!

3. Hoffmann indicated that his disclosed method relates to splitting items using fatigue alone: *"Eventually, after enough load cycles have occurred, the fatigue cracks propagate all the way through the connecting rod 46 and the rod and cap portions 58, 62"*

¹ Rolfe, S. T., and Barsom, J. M. (1977). "Fracture and Fatigue Control in Structures." Prentice-Hall Inc.

are separated from each other.” Paragraph 51. “.. *and the connecting rod is split substantially ENTIRELY by fatigue crack propagation.*” paragraph 52. The same language was used in the claims as well: “.. *propagating the fatigue cracks through the item until the first and second portions are separated from each other.*” Claim 1; “.. *and to propagate the fatigue cracks through the connecting rod until the portions are separated into the cap and the rod.*” Claim 7; “.. *and propagating the fatigue cracks through the connecting rod in radially opposed directions that are substantially parallel to the fracture plane to separate the cap portion from the rod portion.*” Claim 15. Now, considering point 2 of this section; could Hoffmann submit calculations to support his claims that he used fatigue alone to crack a connecting rod by propagating fatigue cracks for a distance of about 12 millimeters while the fatigue exerting force was applied for one hundred load cycles only?

4. If the correct number of load cycles used in the tests is in excess of 1000 cycles as shown in Figure 3, then the time duration of each test is in excess of 100 seconds, almost 15 times the current time cycle for cracking a connecting rod in the industry, why then Hoffmann describes his invention as an improvement over the Resonance-Fatigue and other existing technologies? How could such a slow method be utilized in mass producing connecting rods?
5. While Hoffmann is stating that “*As such, it is desirable to utilize connecting rod materials that are as ductile as possible.*” paragraph 11, however; the tests were performed on connecting rods made of powder metals which are known to be highly brittle materials with low fracture toughness. The separation of connecting rods made of increasingly ductile materials will even take longer time than the separation of powder metal rods.
6. Hoffmann is striving to distinguish his invention from the Resonance-Fatigue invention. In fact the connecting rods in Hoffmann tests were not cracked by fatigue alone as he is claiming; fatigue was used to only weaken the fracture plane THE SAME AS DESCRIBED IN THE RESONANCE-FATIGUE INVENTION¹. A true description of what has happened in the tests is as follows: fatigue cracks are formed and extend for a short distance due to the application of the cyclic load, consequently; the connecting rod is weakened and the critical load required to fracture the rod is reduced; as the cyclic load continues to be applied the rod is further weakened by

¹ The Abstract; patents number: CA 2,287,140 and US 6,644,529.

crack extension and the critical load of the connecting rod is further reduced, once the critical load is reduced to a value equal to the highest magnitude of the applied cyclic load; the crack snap through the remaining ligament of the rod and the separation of the cap and rod portions is completed by FRACTURE not by fatigue crack propagation.

7. Again, if a counter argument is made against the explanation given in point 6 of this section; supporting calculations should be made available showing the following data: what are the values of the fracture toughness K_{IC} of the connecting rod materials? What are the values of the stress intensity ranges ΔK which were applied during the tests? What are the fatigue crack propagation rates due to the stress fluctuation? And finally, what are the time periods needed to extend fatigue cracks through a distance of about 12 mm?
8. The tests described in Hoffmann's invention are similar to tests conducted by the Applicant and described in Chapter 5 of the Thesis. In these tests it was shown that the force required to fracture steel rings was reduced by about 30-50% when cracks were created and extended by fatigue for distances between 0.2-0.3 millimeters.
9. Finally, while Hoffmann has dedicated most of his claims to claim a method of splitting metal items; he dedicated a substantial portion of his specifications to describe a device to implement the method. Another step in an attempt to distinguish his invention from the Resonance-Fatigue invention where no details were given concerning the different devices which could be utilized in implementing the invention.

V Remarks Regarding the Patentability of Hoffmann's Claims

It is the opinion of the Applicant that the invention as disclosed by Hoffmann does not involve an inventive step. However, while the patentability of Hoffmann's invention will ultimately be determined by the Office; it is instructive in this regard to consider the following remarks:

1. Hoffmann's invention is related to a method to split connecting rods and similar items to two portions using **Fatigue** exerting force alone or **Fatigue and Prestressing** forces, the mode of carrying out the invention is the **perpendicular arrangement of the Resonance-Fatigue invention**.
2. Independent claims number 1, 7 and 15 of Hoffmann's invention have the following structure: a) recitation of features that are old and have been very well known in the art for long time to the extent that they represent almost a standard practice in the industry; b) recitation of features that were disclosed in the Resonance-Fatigue publications.

Moreover, all of the claimed combinations and sub-combinations have been disclosed in the published materials of the Resonance-Fatigue technology.

3. Considering the reference to the perpendicular arrangement in US 6,644,529 Column 6, Lines 22-27, then the scope of the Applicant's invention includes that alternative mode of operation which can be described by rewriting the independent claims of US 6,644,529 (claims 1 and 4) so that the phrases describing the application of fatigue exerting force in a parallel arrangement are replaced by phrases describing the application of fatigue exerting force in a perpendicular arrangement. In other words, the scope of the invention includes that alternative mode of operation which can be described by only replacing the phrases which describe: applying a first and second harmonic force where the first harmonic force being substantially equal to and opposite in direction to the second harmonic force along a substantially straight line that is substantially parallel to the predetermined fracture plane, by phrases which describe: applying a harmonic force to one portion of the part in a direction that is perpendicular to the fracture plane.
4. Tables 1 and 2 show comparisons between the rewritten claims of US 6,644,529 and the corresponding claims in Hoffmann's patent application. The features of Hoffmann's claims which are old and well known in the art are written in a different font style for clarity. These old features were referred to in US 6,644,529 as well and are shown in the tables with the same font style. Moreover, the replaced phrases describing the perpendicular arrangement are underlined.
5. Comparing the claims of Table 1, the question that arises is: where is the inventive step of Hoffmann's invention? The differences between the claims are merely due to different wording and different phrasing of the same steps and the same features. **In fact, it is OBVIOUS for a person with ordinary skills in the art that the use of the harmonic force as described in claim 4 of US 6,644,529 shall result in forming radially outwardly extending fatigue cracks in the vicinity of the notches and the propagation of the fatigue cracks through the item.** In fact the matter does not involve the issue of obviousness, since it was expressly stated in the Resonance-Fatigue specifications (see US 6,644,529 column 3, lines 2-6).
6. The same remarks can be made concerning the claims shown in Table 2. The obvious difference between claim 7 of Hoffmann and claim 1 of the Applicant is that claim 1 contains an additional step of applying a dynamic force. In fact, the reason for adding this step is the need to expedite the process as discussed earlier. However, **a person with**

ordinary skills in the art or even with basic engineering knowledge shall ANTICIPATE that should the application of the fatigue exerting force continue the connecting rod would be cracked without the application of the dynamic force. Moreover, Hoffmann's claims presented in Table 2 falls within the scope of the Applicant's amended claims shown in Table 1.

Table 1

US Patent Application No. 10/205,785	US Patent No. 6,644,529
<p><u>CLAIM 1</u></p> <p><i>A method for separating a one-piece metallic item into two pieces, the method comprising: forming an aperture in the item, the aperture surrounded by an aperture surface defining an aperture axis; selecting a fracture plane that is substantially aligned with the aperture axis, the fracture plane dividing the item into a first portion and a second portion; forming two axially extending notches that are recessed with respect to the aperture surface and substantially aligned with the fracture plane; clamping the first portion to substantially fix the first portion; applying a cyclical load to the second portion in a direction that is substantially perpendicular to the fracture plane to urge the second portion away from the first portion, thereby forming radially outwardly extending fatigue cracks in the vicinity of the notches and propagating the fatigue cracks through the item until the first and second portions are separated from each other.</i></p> <p><u>CLAIM 4</u></p> <p>The method of claim 1, wherein prior to applying the cyclical load, a pre-load is applied to the second portion in a direction that is perpendicular to the fracture plane.</p>	<p><i>"For this process, a stress-riser should be provided in a prior process, using any of the known methods, in order to predetermine the fracture plane." Column 2; lines 64-67; (see also 1CR, 1CL, in Figure 1)</i></p> <p><u>CLAIM 4</u></p> <p>A process for the fracture separation of a part having a bore therethrough along a predetermined fracture plane through said part and bore comprising applying a harmonic force to said part so as to fracture separate said part through said bore along said fracture plane; wherein said applied harmonic force comprises <u>applying a harmonic force to one portion of said part in a direction that is perpendicular to the predetermined fracture plane</u></p> <p><u>CLAIM 7</u></p> <p>A process as claimed in claim 6 wherein said part comprises a connecting rod having an integrally formed connecting rod and cap portion and bore therein and fracture separating said cap portion from said rod portion along said fracture plane, including the step of</p> <p>a) Prestressing said cap portion away from said rod portion in a direction substantially perpendicular to said fracture plane.</p>

Table 2

US Patent Application No. 10/205,785	US Patent No. 6,644,529
<p><u>CLAIM 7</u></p> <p><i>A method for separating a one-piece connecting rod into a rod and a cap, the one-piece connecting rod defining a through bore and a bore axis, the method comprising: forming two diametrically opposed and axially extending notches in the connecting rod to define a fracture plane that extends through the thorough bore and is substantially parallel to the bore axis, the fracture plane substantially defining a boundary between a portion of the connecting rod that will become the rod and a portion of the connecting rod that will become the cap; clamping one of the portions to hold the one portion substantially fixed with respect to the other of the portions; applying a load having a load magnitude to the other of the portions in a direction that is substantially perpendicular to the fracture plane; and repeatedly changing the load magnitude to develop fatigue cracks in the vicinity of the notches and to propagate the fatigue cracks through the connecting rod until the portions are separated into the cap and the rod.</i></p> <p><u>CLAIM 8</u></p> <p>The method of claim 7, wherein applying the load comprises applying a mean load having a mean load value, and wherein repeatedly changing the load magnitude comprises oscillating the load magnitude about the mean load value by a load amplitude.</p>	<p><i>"For this process, a stress-riser should be provided in a prior process, using any of the known methods, in order to predetermine the fracture plane." Column 2; lines 64-67; (see also 1CR, 1CL, in Figure 1)</i></p> <p><u>CLAIM 1</u></p> <p>A process for the fracture separation of a connecting rod having an integrally formed cap and rod portion and a bore therethrough, along a predetermined fracture plane through said bore including the steps of:</p> <ul style="list-style-type: none"> a) fixing said rod portion selectively, over a stationary lower jaw, b) fixing said cap portion, selectively, over an upper jaw movable along a straight line substantially perpendicular to the predetermined fracture plane, c) <u>applying a harmonic force to the cap in a direction that is perpendicular to the predetermined fracture plane,</u> and d) applying a dynamic force, by urging said upper jaw away from said lower jaw to thereby fracture said connecting rod into said cap portion from said cap portion along said fracture plane. <p><u>CLAIM 3</u></p> <p>A process as claimed in claim 2, including the step of: a) applying a pre-stressing force to said upper jaw so as to urge, said upper jaw away from said lower jaw and thereby pre-stressing said connecting rod.</p>

7. Moreover, it is instructive in this regard to examine the patentability of Hoffmann's invention considering the information included in the Thesis referred to earlier, in combination with the other Resonance-Fatigue publications. Please notice the following:
- A. The Thesis was available for the public well before the priority date of the above-mentioned patent application. Attached is a copy of a letter from the University of Windsor stating that the Thesis was available at the Leddy library, University of Windsor, Windsor, Ontario, Canada starting from June 12, 2001, since then it was borrowed by several interested parties.
 - B. In Chapter 5 of the thesis, which is entitled "Experimental Analysis", it was indicated expressly that test specimens were made from the same material that is used in the industry to manufacture connecting rods (page 76).
 - C. The geometry of the specimens of the test described in the thesis is almost the same as the geometry of the crankbore portion of an average size light vehicle connecting rod. Moreover, two diametrically opposed stress-risers in the form of two v-notches were formed in all specimens to predetermine the fracture plane (page 77).
 - D. Fatigue-testing machine INSTRON model No. 1332, a servo-hydraulic machine was used in the tests (page 82), a similar machine to the MTS servo-hydraulic machine referred to in Hoffmann's patent application.
 - E. The test was conducted by attaching the lower part of the ring to the stationary lower jaw of the machine, the upper part of the ring to the oscillating upper jaw of the machine, pre-loading the ring by a mean load in a direction that is substantially perpendicular to the predetermined fracture plane, then applying a cyclic load to the upper part of the ring in a direction that is substantially perpendicular to the predetermined fracture plane. The loads and displacements during the tests were recorded. A sample of the recorded data for one of the tests is attached to the Thesis as Appendix "C".
 - F. Test data and results are shown in Table 5.1 of the Thesis (page 83). The pre-load was in the range of 30-55 kN (the lower magnitude of the load range plus half of the load fluctuation range) while the load amplitude was in the range of 10-40 kN (the upper value minus the lower value of the load range) as shown in the second column of the Table. The frequency range was 10-60 Hertz as shown in the third column.
 - G. The first specimen was cracked by applying a static tensile load only in order to determine the critical load required to fracture the ring. It was found to be 101.129 kN. Other rings were cracked by weakening the ring due to the creation and then the extension of fatigue

cracks for a distance of about 0.2-0.3 mm; once the cracks extend so that the critical load of the ring is reduced to reach the upper value of the fluctuating load; the ring is fractured. For instance, specimen number 6 was cracked by applying a pre-load of $10 + (0.5) \cdot (50 - 10) = 30$ kN and a cyclic load that has a load amplitude of $50 - 10 = 40$ kN. The cyclic load created fatigue cracks and the cracks extended for a distance of about 0.3 mm; thereby the ring was weakened and the critical load was reduced from its original value of 101.129 kN to the value of 50 kN, consequently; the ring was cracked by fracture; i.e. by having the fatigue cracks snapping through the remaining uncracked ligament of the ring. **This cracking method is exactly the method claimed by Hoffmann.**

- H. During the test, the rings were positioned so that the fracture plane was parallel to the horizontal and the vertical axis of the machine was perpendicular to the fracture plane. If the rings were positioned so that the fracture plane was vertical; then once the ring is cracked; the two portions would not have been attached to the fixture and they could fly causing injuries to the occupants of the laboratory. Moreover, the Applicant still have the cracked specimens, attached is a copy of two recent photos showing the cracked specimens and a close-up view for one of the specimens. The indentation caused by the fixture showing that the force was applied in a direction that is perpendicular to the fracture plane.
- I. Finally, it should be noticed that the tests lasted for relatively long durations (at least 229 seconds) due to the fact that the area of the cracked cross-sectional area of the ring is more than two times the corresponding area of a connecting rod with the same size since connecting rods contain two large bolt holes and recessed areas.

VI The Priority Issue

Concerning the question of the priority, it is apparent that the Applicant has priority over Hoffmann. This can be concluded by reviewing the filing and publication dates of the two inventions:

1. The first application of the Resonance-Fatigue technology was filed in Canada on October 13, 1999. On June 22, 2000 the first application related to the same technology was filed in the USA and on October 10, 2000 an application was filed through the PCT.
2. On February 13, 2001 Canadian Patent number 2,287,140 was issued and published for the Resonance-Fatigue technology. The Applicant thesis was made available at the Leddy Library of the University of Windsor on June 12, 2001. On April 18, 2002 the PCT

application was published (WO 02/30603 A1). On November 11, 2003 US 6,644,529 was issued and published.

3. The three applications of the Resonance-Fatigue technology in Canada, the USA and through the PCT were identical except that one paragraph was added to the USA and PCT applications (the added paragraph is US 6,644,529 column 6; lines 22-28 which refers to the perpendicular arrangement shown in Hoffmann's application). No modifications were made to any of the applications
4. The first application filed by Hoffmann was a provisional patent application in the USA on July 2001, which means that he had an opportunity to review the Canadian Patent and the thesis, moreover, the first non-provisional application was filed on July 26, 2002, after the publication of WO 02/60303 A1. Hoffmann has also applied through the PCT on July 26, 2002 (PCT/US02/23862, WO 03/015971 A1).

VII Additional Information

While the information included in this section are not pertinent to any of the publications referred to earlier; it deems instructive to make you aware of such issues in order to have a better prospective of the case.

1. The Applicant has submitted a complaint against his previous agent before the Office of Enrollment and Discipline of the USPTO. Please review the File Contents History of the parent case on the PAIR System (Patent 6,644,529). The actions which were taken during the period of January 29, 2003 until July 28, 2003 were taken without the knowledge of the Applicant while he was informed by his previous agent that the issuance of a patent in the US could take that long following the payment of the issue fee. The previous agent never filed a divisional application as he was instructed by the Applicant. The current divisional application was filed by the Applicant himself after he had revoked the agency of the patent agent. Applicant wishes to respectfully draw your attention to the following facts:
 - A. The probabilities to have an invention of an independent inventor to attract the attention of some of the largest automakers are extremely small (please see attachments).
 - B. The probabilities to have a patent agent and an attorney with very extensive experience and a long history of prosecuting patents before the USPTO to commit a series of mistakes such as what happened in my case are extremely small (he is the head of the IP Department of one of the largest legal firms in Canada and has issued more than 175 US patents).

- C. The probabilities to have a divisional application "languishing somewhere within the patent office" or maybe "lost in the mail" are extremely small (the agent claims that he filed a divisional application but it has never been formalized).
- D. The probabilities to have a case of interference are –according to the USPTO statistics– less than 1% (this is a case of substantial interference).

ESTIMATING THE ODDS OF HAVING ALL THE ABOVE MENTIONED EVENTS HAPPENING ACCIDENTALLY TO THE SAME CASE IS LEFT TO YOUR DISCRETION, ESPECIALLY; IN LIGHT OF 35 U.S.C. 135 (B) (1) & (2).

- 2. While the publications related to the Resonance-Fatigue technology are limited to the patent applications and the thesis, however; during the period from October 2000 until now, the Applicant has made many presentations and has submitted detailed information regarding his invention to enormous automakers and auto suppliers and other parties in an effort to commercialize his invention. Please review the attachments to review samples of the commercialization materials and other related documents.

VIII Infringement Concerns

While the Applicant believes that a substantial part of the claimed subject matter of Hoffmann's application are basically his own invention, however; should the Office decide otherwise and ultimately issue a patent to Hoffmann, this issued patent could be used to very easily infringe on any patent rights obtained or yet to be obtained for the Resonance-Fatigue technology. Unlike many of the other methods, Resonance-Fatigue cracking does not leave permanent marks on the connecting rod, a case of infringement will be very hard to substantiate. However, the only protection left to the technology is its uniqueness, especially; in utilizing fatigue in the fracturing process which is a very distinguishable feature that is not used in any other technology. This is especially true; considering the fact that the inventor is an independent inventor and the area of application is the automotive industry. It is apparent that it is already difficult for an individual to enforce his patent rights on the hugely large corporations working in the automotive business.

IX Closing Remarks

Finally, as an Applicant, I wish to inform you that I am neither a patent agent nor a lawyer, however; I am doing my best within the available resources to defend my invention; the fruit of hard working and sacrifices for many years. While I may not be aware of the complex legal issues, however; I am relying upon adhering to the truth and presenting the facts to your just judgment.

Attachments

1. A letter from the University of Windsor indicating that the Thesis was made available at the Leddy Library on June 12, 2001.
2. A copy of a fax forwarded to National Technical Systems (NTS) on April 25, 2001. The fax was submitted following a meeting with the vice president Mr. Loren Isley. During the meeting, details of the Resonance-Fatigue cracking technology were explained. The fax was submitted in order to receive a quotation for fatigue testing connecting rods. The fax contained a detailed drawing for a fixture suggested by the Applicant to conduct the tests. The fixture is showing the perpendicular arrangement of the Resonance-Fatigue invention.
3. A copy of a quotation by National Technical Systems dated April 27, 2001 for conducting the tests referred to in point 2 above. However, the tests were not conducted because the cost exceeded the expected budget.
4. A copy of a letter forwarded to Giddings & Lewis Machine Tools, Fond du Lac, Wisconsin, USA dated May 4, 2001 which represents a sample of the letters forwarded to numerous companies in the efforts to commercialize the invention. The letter included the same fixture referred to in point 2.
5. A letter dated May 8, 2001 from Dr. Manfred Fortnagel the senior vice president of DaimlerChrysler AG indicating that the automaker is interested in the Resonance-Fatigue cracking technology.
6. A copy of presentation material which was made by the applicant during July of 2001 at Alfing Kessler Sondermaschinen GmbH, Aalen, Germany during the Applicant visit to Germany following an invitation by Alfing. The same materials were used in a presentation made by the applicant as well during the same month at the headquarter of DaimlerChrysler AG in Stuttgart Germany. Slides showing the same fixture referred to in point 2 were presented in both presentations.
7. A photo copy of business cards for some of the individuals who attended presentations related to the Resonance-Fatigue technology made by the applicant.
8. A copy of two pictures taken recently for the Thesis test specimens showing the cracked six specimens and a close-up view showing the two diametrically opposed notches defining the fracture plane and the marks caused by the fixture. The close-up view confirms that the orientation of the fracture plane during the tests was perpendicular to the applied cyclic forces.
9. Copies of selected pages of the Thesis.



(Use as many sheets as necessary)

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1. GUIRGIS, SAMEH; "Fatigue Crack Propagation in Steel Components at Resonance"; M.A.Sc. Thesis, 2000, University of Windsor, Windsor, Ontario Canada

Date
Considered

1 Applicant's unique citation designation number (optional). 2 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.